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(74) Agent: **HETHERINGTON, Michael**; Mr. Michael Hetherington, P. O. Box 61047, Palo Alto, CA 94306 (US).

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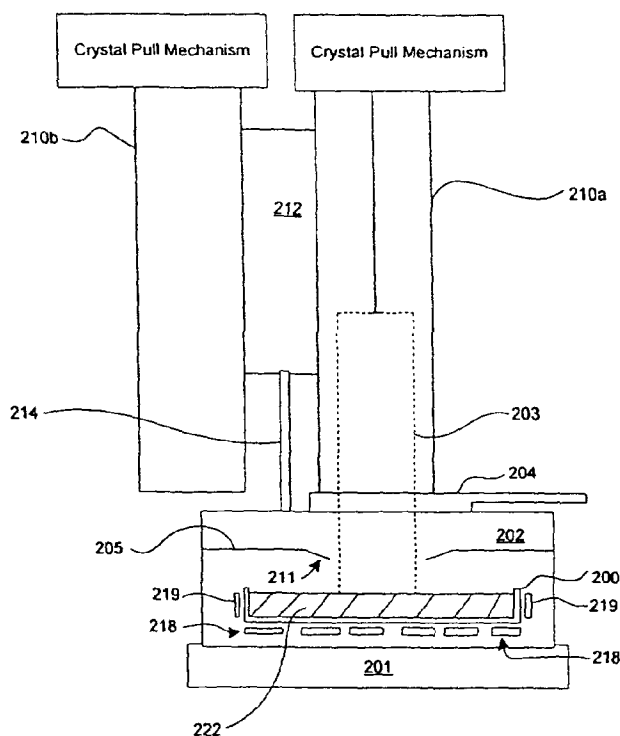
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(71) Applicant (*for all designated States except US*): **SO-LAICX, INC.** [US/US]; Solaicx, Inc., 5102 Calle del Sol, Santa Clara, CA 95054, CA 95054 (US).

(72) Inventor: **BENDER, David, L.**; 2212 Rustic Park Court, Thousand Oaks, CA 91362 (US).

[Continued on next page]

(54) Title: SYSTEM FOR CONTINUOUS GROWING OF MONOCRYSTALLINE SILICON



Low Aspect Ratio Crucible

(57) Abstract: An improved system based on the Czochralski process for continuous growth of a single crystal ingot comprises a low aspect ratio, large diameter, and substantially flat crucible, including an optional weir surrounding the crystal. The low aspect ratio crucible substantially eliminates convection currents and reduces oxygen content in a finished single crystal silicon ingot. A separate level controlled silicon pre-melting chamber provides a continuous source of molten silicon to the growth crucible advantageously eliminating the need for vertical travel and a crucible raising system during the crystal pulling process. A plurality of heaters beneath the crucible establish corresponding thermal zones across the melt. Thermal output of the heaters is individually controlled for providing an optimal thermal distribution across the melt and at the crystal / melt interface for improved crystal growth. Multiple crystal pulling chambers are provided for continuous processing and high throughput.

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**Declaration under Rule 4.17:**

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C30B15/10 C30B29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 C30B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|--|---|
| X | US 4 659 421 A (JEWETT DAVID N [US]) 21 April 1987 (1987-04-21) the whole document ----- | 1-31 |
| X | WO 86/06109 A (ENERGY MATERIALS CORP [US]) 23 October 1986 (1986-10-23) the whole document ----- | 1-31 |
| A | WO 03/038161 A (MIDWEST RESEARCH INST [US]; WANG TIHU [US]; CISZEK THEODORE F [US]) 8 May 2003 (2003-05-08) the whole document ----- | 1,6,11, 15,17, 23,24, 27,29,31 |
| A | DE 26 34 256 A1 (GNI I PI PEDKOMETALLITSCHESKOJ) 2 February 1978 (1978-02-02) ----- -/-- | |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *A* document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Cook, Steven

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|--|-----------------------|
| A | US 4 410 494 A (FIEGL GEORGE [US]) 18 October 1983 (1983-10-18) ----- | 1-31 |
| A | US 4 650 540 A (STOLL MILTON [US]) 17 March 1987 (1987-03-17) ----- | |
| A | US 4 454 096 A (LORENZINI ROBERT E [US] ET AL) 12 June 1984 (1984-06-12) the whole document ----- | |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2005/006058

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US2005 /006058

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-13,15-17,23-31

CZ system/apparatus for melting crystalline feedstock, growing single crystal ingot using a wide diameter low aspect ratio crucible. Process using such and product obtained therefrom.

2. claims: 14,18-22

CZ system, pre-melter apparatus for growing, providing continuous flow of molten crystalline feedstock.

| Patent document cited in search report | | Publication date | Patent family member(s) | Publication date |
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